Title of the Research: **Lattice Boltzmann methods: Application and Development**

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Abstract: Over the past few decades, a great deal of research work has been invested for the formulation of efficient numerical schemes to solve numerically partial differential equations. Recently, the lattice Boltzmann equation (LBE) method has gained much attention for its ability to simulate fluid flows, and for its potential advantages over conventional numerical solution of the Navier–Stokes (NS) equations. Currently, a number of complex flow problems are being simulated using the LBE approach. The key advantages of LBE are, (1) suitability for parallel computations, (2) absence of the need to solve the time-consuming Poisson equation for pressure, and (3) ease with which multiphase flows, complex geometries and interfacial dynamics may be treated. However, there are certain difficulties inherent to the LBE methodology, which are being examined by a large number of investigators. Considering the rapid pace with which the subject is developing, in the foreseeable future the LBE method is likely to play a significant role in the numerical prediction of flows. The primary objective of the research proposal is the development of an efficient Lattice Boltzmann method for solving linear and nonlinear partial differential equations. We will make a comparative study with the existing Higher Order Compact and Bi-harmonic methods. The secondary objective is to do optimized study concerning higher order LBE. Thus, the newly developed scheme will be also applied on nonlinear shallow water-wave equation and incompressible viscous flows governed by Navier-Stokes equations. The computational framework is thus expected to be a useful tool in understanding the complex flow physics in free and forced convection flows, flows past a bluff body, and fluid and heat transfer in a complicated geometry.

The common terminology used in LBM is refer to the dimension of the problem and the number of speed is using DnQm, where **n** represent the dimension of the problem (1 for 1-D, 2 for 2-D and 3 for 3-D) and **m** refers to the speed to the model, number of linkages.

In general, two models can be used for lattice arrangements for 1-D, called D1Q3 and D1Q5.

In 2-D two models can be used for lattice arrangements, called D2Q5 and D2Q4.

In 3-D two models are used in simulation of three dimensional problems, D3Q15 and D3Q19.

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